APPARATUS AND METHOD FOR WIRELESS
LOCAL AREA NETWORKS OF DIFFERENT COUNTRIES

Cross-Reference to Related Applications

5   This is a continuation in part of U.S. Patent
Application No. 09/172,180, filed October 13, 1998,
hereby incorporated by reference herein in its
entirety, and is related to U.S. Patent Application No.
08/747,034, filed November 8, 1998, now U.S. Patent
10   6,002,918, hereby incorporated by reference herein in
its entirety.

Background of the Invention

The invention relates to communication
systems, and more particularly to wireless local area
15   network (WLAN) communications systems in which
communications characteristics are based on WLAN
specifications for the country in which the system is
operating.

A WLAN communications system may be
20   implemented by remote terminals (e.g., mobile units)
that send messages to and receive messages from base
stations or access points using wireless infrared or
radio communication links. Each access point or base
station covers a limited area, so a typical network may
25   have several base stations or access points.

One protocol that may be used in such communications systems is the IEEE 802.11 Standard as published. The IEEE 802.11 is a standard that defines physical and data link layers for wireless local

5 networks (e.g., networks that include access points and remote terminals). The standard defines, among other things, the wireless local area network (LAN) medium access control (MAC) and physical (PHY) layer specifications.

10 In the 802.11 standard, for a remote terminal to transmit a message, the remote terminal may first have to become associated with an access point. Association refers to the process of synchronizing a remote terminal with an access point for communication,

15 and is initiated by the remote terminal. The remote terminal may first listen to broadcasts over the airwaves and determine which access points are within range of the remote terminal, and then request association with a particular access point according to

20 certain criteria. At any point in time, a remote terminal is typically associated with only one access point. A single access point can be associated with multiple remote terminals.

With the ever-growing global market, it is

25 common for WLAN users to travel from country to country. A problem therefore occurs, in that one country may allocate a different portion of the frequency spectrum to wireless communications than another country. Different frequency bands or

30 overlapping frequency bands may have been assigned for use by WLAN communication systems of different countries. Typically, WLAN communication systems are assigned to frequencies that do not require the system user to obtain a license from the government to operate

the communications system.   The unlicensed frequencies
for WLAN communications systems of a particular country
are typically available for use throughout that country
by any WLAN communication system user. Additionally,
5 different countries may have different regulations that
provide specifications for operating WLAN systems in
that country (e.g., parameters for spread spectrum
communications may differ, power requirements may
differ, etc.). These allocations and specifications
10 may prevent a remote terminal that is designed for use
in one country from working (or being allowed to work
or suitably operating) in a WLAN communications system
in another country.

      What is needed, then, is a system and method
15 for allowing remote terminals to meet regulatory
requirements, and adapt to and communicate with access
points having different communications characteristics.

Summary of the Invention

      The present invention relates to an apparatus
20 and method for adapting a remote terminal to
communications requirements of a particular country or
geographic region. In one aspect of the invention, a
wireless data communications network including a remote
terminal and one or more access points is operated to
25 receive, at the remote terminal, announcement messages
that have been broadcast by one or more of the access
points. Each of the messages may have a unique
frequency characteristic associated with the geographic
location of the access point from which it was sent.
30 The unique frequency characteristic may be used in the
remote terminal to determine an allowable frequency set
in the geographic region associated with the access
point from which each of said messages was sent, and to

adjust the frequency set of the remote terminal to send
messages on said allowable frequency set. Other
operating characteristics may be adjusted in similar
fashion.

5   In another aspect of the invention, country-
specific information in communications messages may be
used to adapt remote terminals to operate based on WLAN
operating specifications of different countries.
A communications message having country specific

10   information may be a broadcast transmission (e.g., an
announcement message) of an access point. If desired,
the communications message may be a reply
communications message sent by an access point in reply
to a probe communications message from a remote

15   terminal. The probe communications message may have
been sent after the remote terminal received a
communication (e.g., a broadcast transmission, a
communications message from another remote terminal,
etc.) from a component of a nearby WLAN (e.g., an

20   access point of a nearby WLAN) and the probe
communications message may have been sent on a
frequency channel on which the remote terminal received
the communication. The remote terminal may have been
scanning a range of frequencies on which the remote

25   terminal is operable (e.g., frequencies for different
countries) to receive a communication. The remote
terminal may have been scanning frequencies seeking to
associate with an access point to commence wireless
operation. Some country-specific information may have

30   been stored at the remote terminal to aid in adapting
the remote terminal when country-specific information
has been received from an access point.

Brief Description of the Drawings

Further features of the invention, its nature and various advantages will be more apparent from the following detailed description, taken in conjunction
5 with the accompanying drawings in which like reference characters refer to like parts throughout, and in which:

FIG. 1 is a diagram of an illustrative communications network that includes an illustrative
10 wireless local area network communications system in accordance with the present invention;

FIG. 2 is a diagram of an illustrative wireless local area network communications system in accordance with the present invention;

15 FIG. 3 is a flow diagram of an illustrative method for operating a wireless network communications system in accordance with the present invention;

FIG. 4 is a flow diagram of an illustrative method for adapting remote terminals based on country-
20 specific information in accordance with the present invention;

FIG. 5 is a flow diagram of an illustrative method for adapting remote terminals based on country-specific information that is carried in a broadcast
25 transmission in accordance with the present invention; and

FIG. 6 is a flow diagram of an illustrative method for adapting remote terminals based on country-specific information sent in reply to a probe message
30 in accordance with the present invention.

Detailed Description of the Invention

The IEEE 802.11 standard as published
provides specifications for WLAN communications world-
wide. However, there are some variations in WLAN
5   operation from country to country. These variations
may have been provided by regulations in each country,
in the IEEE 802.11 standard, or otherwise.
Manufacturing different WLAN components for each
country is costly, time-consuming, expensive,
10   inefficient, etc. In accord with the principles of the
present invention, to substantially alleviate demands
such as those discussed above, universal remote
terminals may be provided that automatically adapt to
operate in different countries.
15   With reference to FIG. 1, WLAN communications
system 20 may include a plurality of cells 22 (only one
is shown for simplicity). Cell 22 may include an
access point 24 (which is sometimes referred to as a
wireless local bridge) that was installed in a
20   particular country to operate based on WLAN
specifications for that country. Cell 22 may include
remote terminals 26 that are associated with access
point 24 and are operating based on WLAN specifications
of the country of access point 24. Each terminal 26
25   may be a mobile, portable, or stationary terminal.
Terminals may be implemented as programmable processor-
based units executing software modules. Each
terminal 26 may be a desktop workstation, laptop
computer, personal computer, palm top computer,
30   handheld personal computer, pen-based computer,
personal digital assistant, handheld scanner, data
collector, handheld printer, etc. Each terminal 26 may
include wireless-network-interface resources that are
configured to provide two-way radio or infrared signal

communications. Such resources may include an interface card (or an external modem), a software driver, and an antenna. Other suitable resources may also be used, but for clarity and brevity, the wireless

5   network interface resources will be discussed primarily in the context of an interface card, a software driver, and an antenna. The interface card may have been configured to use a standard computer-bus interface (e.g., ISA, PCMCIA, etc.) or standard computer port

10 (e.g., RS232, RS422, etc.) to provide convenient access to terminal equipment. If desired remote terminal 26 may include suitable hardware and/or software to include database 44 that includes information on communications specifications of different countries.

15   A network-operating-system may be implemented on each terminal 26. In each terminal 26, the interface card may be coupled to the network-operating-system using the software driver. The interface card for each remote terminal 26 may be a

20 network-communications interface. The network interface card for each terminal 26 is typically implemented to use a carrier sense access protocol and to modulate communications signals with a spreading sequence.

25   Access point 24 may be an interface for communicating between wireless network 20 and a wireline network. Access point 24 may be configured to provide a communications gateway between terminals 26 that are in cell 22 and between a wireline network and

30 the terminals 26. Access point 24 may include a resource(s) (e.g., software, hardware, or a combination thereof) that is configured to connect the access point to a wireline network (e.g., on ethernet network, a token ring network, etc.). Access point 24 is

typically configured to convert signals between
wireline and wireless communications mediums. The
conversion may allow the access point to pass
communication information between the wireline network
5 and wireless remote terminals 26.

Access points are typically provided with
sufficient processing, hardware, software, etc. to
operate in compliance with the IEEE 802.11 (e.g., to
provide 802.11 roaming, standard 802.11 data rates,
10 etc.), to provide country-specific characteristics, and
to provide additional features that are developed by a
vendor. Access point 24 may be implemented using a
personal computer (e.g., a Power PC, an IBM compatible
computer), server, workstation, etc., having an
15 appropriate operating system, wireless-network-
interface resources, wireline-network-interface
resources, network-operating-system applications, etc.
If desired, access point 24 may include suitable
hardware and/or software for database 42 that may
20 include information on communications specifications
that are particular to the country in which access
point 24 is installed. In systems in which access
point 24 includes database 42, remote terminal 26 may
be without database 44, or if desired, there may be a
25 database that is partially implemented in access
point 24 and partially implemented in remote
terminal 26.

Access point 24 and remote terminals 26 may
be configured to communicate using spread spectrum
30 modulation techniques (e.g., direct sequence spread
spectrum modulation, frequency hopping spread spectrum
modulation, etc.).

The IEEE 802.11 standard includes
specifications describing communications packets (e.g.

format, content, etc.). Communications packets, which
may also be referred to as frames or messages, may be
of variable size with the size of each packet being
identified in packet header information. In some
5   embodiments, the body of each packet may vary
from 0 to 2312 octets.

     Each terminal 26 may have different
communications capabilities and requirements. Access
point 24 may manage the communications traffic between
10 terminals 26 and the wireline network. Access point 24
may manage the communications traffic by controlling
when packets are transmitted to each remote terminal 26
that is associated with access point 24 in cell 22.
The communications traffic in cell 22 may include data
15 packets (e.g., signals that carry packets to provide
data communications), voice packets (e.g., signals that
carry packets to provide voice communications), real-
time packets (e.g., signals that carry packets to
provide real-time communications such as multimedia or
20 voice communications), management packets (e.g.,
signals that carry packets to provide network
management communications), etc.

     The wireline network that is coupled to
access point 24 may include equipment 23 that is
25 configured to implement the wireline network. The
wireline network may be coupled to an external network
(e.g., PBX, PSTN, Internet, etc.).

     For clarity and brevity, the apparatus and
methods discussed hereinafter are discussed primarily
30 in the context of messages, rather than being discussed
for example in the context of frames or packets.

     FIG. 2 is a block diagram showing a wireless
network architecture. Host 10, which is for example,
equipment that is configured to provide communications

between access points, is connected to access point 12
and access point 14. Access point 12 handles wireless
communications within area 16, and access point 14
handles communications within area 18. As shown in
5   FIG. 2, therefore, access point 12 is in communication
range of remote terminal 30 and remote terminal 32, and
access point 14 is in communication range of remote
terminal 30 and remote terminal 34. Remote terminal 30
is in communication range of either access point 12 or
10   access point 14, although remote terminal 30 preferably
only communicates with one of them at a time.

In one scenario, remote terminal 20
associates with access point 12 and thereafter
communicates with access point 12 to transmit messages
15   to the host or to other remote terminals. If remote
terminal 20 is associated with access point 12, remote
terminal 30 could transmit a message to remote
terminal 32 via access point 12, or to remote
terminal 34 via access point 12, host 10, and access
20   point 14. A wireless local area network communications
system typically comprises a grouping of hosts and/or
remote terminals.

Systems such as those depicted in FIGS. 1
and 2 may be installed throughout the world. Each
25   country, however, (as discussed above) typically has
different operating parameters for use of such systems
in that country. According to an embodiment of the
present invention, a remote terminal may be configured
with circuitry (e.g., hardware and/or software) to be
30   operable on a variety of different frequencies. Remote
terminals may include wireless-network-interface
resources comprising the circuitry. The range of
frequencies should be large enough to encompass some of
the frequencies available for wireless communications

in each country or geographic region in which the
remote terminal is to operate. The remote terminal may
be configured to operate at a variety of different
power settings, with the range of power settings being
5   large enough to encompass at least some allowable power
settings in each country in which the remote terminal
is to operate. The remote terminal may be configured
to operate at a variety of spread spectrum
communications settings, again with the variety of
10   settings being large enough to encompass at least some
operable settings in each country in which the remote
terminal is to operate. These features allow the
remote terminal to operate in a variety of different
countries or geographic regions.
15   Remote terminals may automatically adapt to
use in individual countries or geographic regions by
running a program or method contained in software
and/or hardware within the remote terminal, such as
circuitry of the remote terminal having suitable
20   hardware and/or software. The wireless-network-
interference resources of a remote terminal may
comprise this circuitry. FIG. 3 is a flow diagram
showing illustrative steps involved in adapting a
remote terminal for use in individual countries or
25   geographic regions based on frequency. characteristics
of messages. At step 50, the remote terminal may scan
the frequency spectrum, listening for broadcast
transmissions or announcement messages broadcast by
access points. This may encompass tuning to each
30   available frequency on which an announcement message
from a nearby access point may be received. The
announcement message may have a frequency
characteristic that is unique to a particular
geographic region or country (e.g., transmitted on a

frequency channel that is unique to a particular country).

At step 52, the frequency characteristics of the received announcement message are compared with a table, database, or equivalent data structure contained in memory. The table may contain a listing of the breakdown of the frequency spectrum for all the different available countries or geographic regions. It also may list regulations on power output or other regulations important to the functioning of the remote terminal. At step 54, a matching country or geographic region is found. At this point, the remote terminal has determined what country or geographic region in which it is operating. At step 56, the remote terminal adjusts its operating frequency range to correspond to the country or geographic region in which it is operating. It may also alter other operating characteristics, such as power output and modulation type, in accordance with the regulations listed in the table or other data structure corresponding to the country in which the remote terminal is located.

After the geographic region frequency, power settings or any other operating characteristics have been adapted for use in the country or geographic region in which the terminal is located, the remote terminal operates similarly to a conventional remote terminal.

FIG. 4 is a flow chart showing illustrative steps involved in adapting a remote terminal for use in individual countries or geographic regions based on country-specific information from access points. At step 60, a transmitter, such as an access point, that has been installed in a particular country may be operated based on operating specifications for WLANs in

that particular country. At step 62, the transmitter
may transmit a communications message comprising
information that is specific to the country in which
the transmitter is operating. The information that is
5   specific to the country may be provided as bit flags or
encoded words in a transmitter communications message.
The information may include country name, WLAN
operating channels for that country, country settings
for variable spread spectrum communications parameters,
10   etc. If desired, the format of the information in the
message may be predetermined by WLAN vendors or
operators (e.g., the information may be formatted to
identify the first channel in the operating bands for
that country with the information further including
15   values from which the location of other channels for
that country may be identified).

          Country-specific information may include
direct sequence spread spectrum communications
parameters such as, the sequence and channel numbers,
20   may include frequency hopping spread spectrum
communications parameters such as, the frequency hop
characteristics, may include the first channel, the
number of channels, a table of channels, the type of
spread spectrum communications, etc.

25   At step 64, a remote terminal may receive the
communications message comprising the country specific
information. In response to receiving the
communications message, the remote terminal adapts
(e.g., remote terminal circuitry is configured to
30   adapt) to operate in that country based on that
country's operating specifications for WLANs. If
desired, the remote terminal may include a table,
database, datastructure, etc. of information on some or
all of the operating requirements of different

countries. If desired, at substep 64a, the remote
terminal may compare the information received from the
transmitter in the communication message to information
at the remote terminal. For example, the transmitter
5   may have sent a message carrying the name of the
current country and the remote terminal may compare the
received name to names of countries that are stored at
the remote terminal. If desired, at substep 64b, the
remote terminal may find a matching country name that
10   has WLAN operating specifications associated with it
for that country. Substeps 64a and 64b may be
individual steps that are separate from step 64.

FIG. 5 is a flow chart showing illustrative
steps involved in adapting a remote terminal for use in
15   individual countries or geographic regions based on
country specific information that is in a broadcast
transmission from an access point. At step 80, a
remote terminal may scan frequencies. For example, the
remote terminal may scan frequency channels on which it
20   may operate in a plurality of countries. The remote
terminal may be scanning to receive a broadcast
transmission from an access point when the remote
terminal is seeking to associate with an access point.
At step 82, an access point may transmit a broadcast
25   transmission that includes country-specific
information. For example, an access point that has
been installed in a particular country to operate based
on WLAN operating specification for that country
broadcasts a communications message for any remote
30   terminal within its communication range where the
message includes country-specific information, such as
the WLAN operating channels for that country.
At step 84, the remote terminal may receive the
broadcast transmission and the country-specific

information included therein. At step 86, in response
to receiving the broadcast transmission, the remote
terminal adapts to operate based on the WLAN
specifications for the country in which the access
5 point is operating (e.g., the remote terminal operates
only in the WLAN operating channels for that country
while adapted to operate in that country).

FIGS. 6a and 6b together show a flow chart of
illustrative steps involved in adapting a remote
10 terminal for use in individual countries or geographic
regions based on country-specific information that has
been requested by the remote terminal. At step 100, a
remote terminal may scan frequencies to find a
transmitted communication. The remote terminal may be
15 scanning to find a communication channel carrying a
communication of a nearby WLAN. The communication may
be a broadcast transmission of an access point, or if
desired the communication may be a communication
message that is typically used in WLAN operation.
20 At step 102, a component (e.g., an access point) of a
nearby WLAN may transmit a communication on a
particular channel. For example, an access point may
transmit a broadcast transmission on one of the
frequency channels that are available to WLANs in the
25 country in which the access point is operating.
At step 104, the remote terminal may receive the
communication. For example, the remote terminal may
have been recently activated and may be seeking to
associate with an access point when the remote terminal
30 receives a communication that is a broadcast
transmission sent on a particular channel.
At step 106, the remote terminal may send a probe
communications message to the access point. The remote
terminal may send the probe message in response to

receiving the communication and may send the message on
the channel on which the communication was received.
The remote terminal may be of the type that may not be
able to transmit until knowing a valid channel for
5   communications. If desired, the probe message may have
been sent to request information including country-
specific information from the access point.
At step 108, the access point may receive the probe
message. If desired, the access point may locate for
10   the remote terminal country-specific information from
information stored at the access point. At step 110,
the access point may transmit a communications message
comprising country-specific information in response to
receiving the probe message from the remote terminal.
15   If desired, country-specific information may have been
also included in the communication that the remote
terminal received at step 104. At step 112, the remote
terminal may receive the communications message.
At step 114, the remote terminal may adapt to operate
20   based on WLAN operating specifications for the country
of the access point.

        Some regulations require that the regulations
themselves be displayed to the user. Normally, these
regulations would be placed on the outer surface of a
25   remote terminal capable of transmitting in the country.
However, since the remote terminal may be capable of
transmission in many different countries, this may not
be feasible. Therefore, the remote terminal may be
configured such that, after the unit has determined the
30   country in which it is located, the proper regulatory
information is displayed to the user.

        The contents of U.S. Patent No. 5,029,183 to
Tymes, and U.S. Patent No. 5,668,803 to Tymes et al.,
both assigned to Symbol Technologies, Inc., are hereby

incorporated by reference herein. These patents show
systems in which methods and apparatus consistent with
the principles of the present invention may be
practiced. Each patent describes a system in which
5   hand-held data-gathering mobile remote terminals
communicate via wireless link with access points,   .
similar to the system shown in FIG. 1.

If desired, the remote terminal may be
configured so that the user must verify the country in
10   which they are located. For example, if the remote
terminal determines by looking at a table that it is
currently located in Switzerland, a message may appear
on a display screen on the remote terminal saying "You
are in Switzerland. Is this correct? (Y/N)." The user
15   may then be required to confirm that he or she is
indeed in Switzerland before the remote terminal
reconfigures its settings to comply with Swiss
standards. This reduces the chance of the remote
terminal mistakenly configuring itself to specific
20   characteristics that may violate certain regulations.

If desired, a Global Positioning System (GPS)
locator may be built into the remote terminal, allowing
the unit to verify its location instead of or in
addition to requiring confirmation from the user. This
25   feature also reduces the chance of the unit mistakenly
configuring itself to specific characteristics which
may violate certain regulations.

If desired, the multiple geographic region
feature (the feature embodied by the above methods) may
30   be enabled or disabled by a user. When the feature is
disabled, the remote terminal merely attempts to
establish communication using a communication setting
for a particular geographic region. This setting may
be, for example, a default setting or the setting in

use at the time the remote terminal was last turned
off.

Accordingly, the apparatus and methods
discussed herein allow for universal remote terminals
5   that adapt to operate in countries world-wide. For
example, based on the embodiments discussed herein,
every time a remote terminal associates with a new
access point in a different country, the remote
terminal may adapt to that country's requirements to
10   suitably operate throughout that country.

In one embodiment, remote terminals (e.g.,
remote terminals 20, 22, and 24 of FIG. 2) are hand-
held data-gathering units. An advantage of such
apparatus and methods is that for data-gathering remote
15   terminals that are mobile, handheld, compact, etc.,
users may easily migrate to different countries to use
their remote terminals without added cost, complexity,
equipment size, etc.

The foregoing is merely illustrative of the
20   principles of this invention and various modifications
can be made by those skilled in the art without
departing from the scope and spirit of the invention.